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GEOLOGICAL INVESTIGATION OF THE WESTERN LOWLANDS AREA LOWER MISSISSIPPI VALLEY

by

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and

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PURPOSE AND SCOPE

1. The engineering-geologic maps and cross sections contained in this report were prepared to (a) show the areal distribution of the major environments of deposition of alluvial sediments, (b) illustrate the typical soils conditions associated with each major environment, (c) delineate the configuration of the buried erosion surface formed on Tertiary formations, and (d) identify the age and basic lithologic character of the Pleistocene and Tertiary formations exposed in the uplands and situated below the alluvium.

2. The intent of this study was to produce a product which should be considered only as reconnaissance geologic mapping. The mapping techniques employed and the amount of subsurface data available for interpretation precluded producing maps or sections with accuracy sufficient for such purposes as detailed site investigations. Rather, the maps and sections are intended for and should be of considerable value in such activities as (a) boring program planning, (b) preliminary site selection, (c) basin-scale planning and development, (d) regional groundwater investigations, and (e) regional ecologic or environmental studies.

3. This report is the sixth in a series of loose-leaf folders of engineering-geologic quadrangle maps for major basin or lowland areas of the Lower Mississippi Valley and tributaries. With completion of the series during the next several years, maps at a common scale (1:62,500) and with the same format and with accompanying cross sections will be available for the entire alluvial valley of the Mississippi River and its major tributaries within the Lower Mississippi Valley Division (208 quadrangles).

MAPPING PROCEDURE

4. Aerial photos at scales of 1:20,000 and 1:40,000 and photo index mosaics at a scale of 1:63,360 were used for the delineation of the environments of deposition of alluvial deposits. Information on the nature and configuration of the Pleistocene and Tertiary formations was principally extracted from published geological literature, including state geological survey bulletins and groundwater investigation reports by the U. S. Geological Survey (USGS). County soil survey reports by the U. S. Department of Agriculture contributed some information on surface soils conditions.

5. All subsurface information in the form of boring logs on file at the U. S. Army Engineer Waterways Experiment Station (WES) and available from the U. S. Army Engineer District, Memphis (MED), was used in this study. In addition, subsurface data were acquired from the files of the USGS in Little Rock, Ark., the Missouri Geological Survey, the state highway departments of Arkansas and Missouri, and private well drilling firms. The data from the MED and the state highway departments are of high quality and detail but seldom extend deeper than 50 ft. Consequently, the mapping of the top of the Tertiary formations beneath the alluvium and the lower part of the alluvium itself was accomplished primarily with the rather low-quality logs of relatively deep water wells.

6. In much of the engineering-geologic mapping in the Lower Mississippi Valley, it has been possible to differentiate the basic soils types of the various environments of deposition and to portray this information in color on the cross sections where relatively closely spaced borings were available. However, the paucity of detailed subsurface data from the Western Lowlands area will not permit such differentiation. Instead, it has been possible only to differentiate the alluvium of each environment into a basically fine-grained or cohesive-soil topstratum and a basically coarse-grained or noncohesive-soil substratum.

GEOGRAPHIC SETTING

7. The physiographic division of the Lower Mississippi Valley known as the Western Lowlands is situated between Crowleys Ridge on the east and the Ozark Escarpment and the Grand Prairie region on the west (fig. 1). In a north-south direction, it extends from the present Mississippi River near Cape Girardeau, Mo., southward to the vicinity of Big Creek or the present Mississippi River meander belt southwest of Helena, Ark. In its northern part, the Western Lowlands includes a number of lesser physiographic divisions such as the Advance and Drum Lowlands.

8. The principal drainage of the Western Lowlands includes the Black, Current, Spring, and White Rivers which discharge from the Ozark Plateau and eventually combine as they flow southward along the extreme western side of the lowlands. The secondary drainage, including the Cache and L'Anguille Rivers and Bayou DeView, also flows southward, reflecting the regional slope of the lowland deposits. Only the St. Francis River departs from the general trend by flowing southeastward across the northern end of the lowlands and then turning abruptly eastward through a gap in Crowleys Ridge into the Eastern Lowlands.

9. Although the general regional slope of the Western Lowlands is to the south, the topography also exhibits a distinctive westward slope starting at the base of Crowleys Ridge. The slope is a result of a series of low, flat terraces or levels created because of the downcutting and progressive westward shifting of the braided streams that deposited the bulk of the lowland sediments. In general, the most irregular terrain, being in the form of gently rolling, dissected plains, occurs on the older and higher levels or terraces near Crowleys Ridge. The lowest relief and consistently flattest terrain occur in the floodplains of the Black and White Rivers.

10. The mapping accomplished in this study basically covers only that part of the Western Lowlands included in the MED. That part of the lowlands, principally the northwestern part, lying west of the district limits was mapped only on the quadrangles shown on the index map (fig. 1). The part of the lowlands located in Missouri, although mostly in the MED, was excluded from this study but will be mapped later as part of the St. Francis Basin mapping project.

GEOLOGIC HISTORY

11. The geologic events that were largely responsible for the creation of the Western Lowlands began during the early or middle part of the Quaternary period. As shown in fig. 2, all of the formations exposed in Crowleys Ridge and underlying the lowland alluvium are of Tertiary or Cretaceous age. During the very late Tertiary and early Quaternary periods, these formations were much more extensive as upland areas in the Western Lowlands. The only lowlands or alluvial plains were probably restricted to the narrow valleys of the White, Black, and other rivers that flowed generally southward or southeastward through the area, their courses influenced principally by the outcrop pattern of the Tertiary formations and by faulting.

12. Early in the Quaternary period, the Mississippi and Ohio Rivers began to exert a strong influence on the Western Lowlands area. The first manifestation of this is the capping of deposits of sand and gravel over much of the uplands of Crowleys Ridge and the eastern edge of the Ozark Plateau. These graveliferous materials probably represent glacial outwash that was laid down by ancestral braided courses of the Mississippi River and possibly also the Ohio River. It is apparent that these rivers were flowing at a much higher level at the time they deposited the widespread graveliferous materials.

13. The approximate time at which the Mississippi and Ohio Rivers began to entrench themselves into the Tertiary formations and older Quaternary deposits to form the Lower Mississippi Valley essentially as it exists today is not known. However, the Prairie terrace formation (fig. 3) stands as evidence that this event occurred sometime before the Sangamon Interglacial Stage, that is, more than 100,000 years ago. This terrace formation indicates that an entrenched valley had been carved by the ancestral rivers during a preceding glacial stage and that a large volume of sediments, including both initial glacial outwash and later meander belt deposits, had been laid down in a valley very similar in size and shape to the present valley.

14. During the onset of the Early Wisconsin glaciation, much of the Prairie terrace formation was destroyed by entrenchment and lateral migration and erosion by streams. In the Western Lowlands area, it was the Mississippi River that destroyed the Prairie terrace formation in all but the Grand Prairie region. At this time and for considerable time to come, the Mississippi River discharge was confined to the area west of Crowleys Ridge, while the Ohio River was the principal stream in the northern part of the Lower Mississippi Valley east of Crowleys Ridge.

15. Present concepts of alluvial valley history and chronology indicate that the large volume of glacial outwash that fills the Western Lowlands and that forms the higher terrace levels (Qtb_1, Qtb_2, and Qtb_3 levels, fig. 3) was derived from the melting of the Early Wisconsin glaciation prior to about 30,000 years ago. There can be no doubt that the lowlands area was once completely filled to a level equal to the highest level mapped; that is, the Qtb_1 level. The progressive downcutting and westward shifting of the ancestral Mississippi River that created the terraces probably occurred shortly after the waning or decline of the glaciation during the latter part of the brief mid-Wisconsin interglacial stage known as the Farmdalian Substage. Some glacial outwash apparently continued to be carried into the lowlands area during the waxing or growth of the following Late Wisconsin glaciation. The valley trains or principal outwash-carrying channels, as partly evidenced by the Qtb_4 level, were then located near the base of the Ozark Escarpment along the routes of the present Black and White Rivers and along the route of the Cache River.

16. Although many aspects of the depositional chronology are imperfectly known, it appears as though much, if not most, of the glacial outwash resulting from the waning of the Late Wisconsin glaciation was deposited east of Crowleys Ridge. This major change in pattern of deposition was brought about by a diversion of the ancestral Mississippi River through a gap in the northern end of Crowleys Ridge into the Eastern Lowlands. Thus, the Mississippi and Ohio River valley trains combined and developed southward; the Qtb_5 level, or terrace, shown in fig. 3 probably represents some of the Late Wisconsin glacial outwash that was deposited by a channel that curved southwestward around the southern end of Crowleys Ridge just south of Helena, Ark. (fig. 1).

17. Since the diversion of the Mississippi River into the Eastern Lowlands at a time probably approximating the Pleistocene-Holocene boundary about 12,000 years ago, the Western Lowlands has been without a major source of sediments. Consequently, the higher braided terraces have developed their own drainage patterns with slightly entrenched but meandering streams to accommodate local runoff. Similarly, the more major through-flowing streams such as the Black and Current Rivers have created moderately wide floodplains with numerous abandoned courses, abandoned channels, and other meander belt features. During the past several thousand years, these streams have aggraded their floodplains a maximum of a few tens of feet in response to changing patterns of runoff and discharge and have eroded away large portions of the lower braided levels, particularly the Qtb_3 and Qtb_4 levels.

18. One of the more conspicuous Holocene features in the Western Lowlands is the abandoned meander belt which is currently occupied by the Cache River but which was obviously created by a much larger stream. A reasonable explanation for this feature is that it was formed by the combined flow of the Black and St. Francis Rivers prior to the time the former stream diverted westward to the base of the Ozark Escarpment and the latter stream diverted eastward through a gap in Crowleys Ridge. The abandoned meander belt occurs in the form of a low terrace along most of its mapped extent since the Cache River is slightly entrenched; however, south of the junction with the White River, the meander belt is buried as a result of alluviation by the latter stream.

19. An unusual aspect of the Western Lowlands is the extensive tracts of sand dunes that lie principally just east of and trend parallel to the White and Black Rivers. The dunes apparently lie on the bars and braided-channel islands of the last Mississippi River valley train to be active in the area. This valley train is presumed to be the source of the sand of which the dunes are composed. Recognizable specific dune shapes are generally absent, and many areas may be appropriately described as hummocky sand sheets with numerous blowouts and/or depressions. The highest dunes and the most extensive contiguous areas occur on the Knobel and Walnut Ridge quadrangles (see plates similarly designated) where local dune field relief of 20 ft is not unusual and areas of over 10 sq mi are continuously veneered with the eolian sand deposits. Areawise, the dune fields are significant in the lowlands area; over 180 sq mi are thus characterized in the area mapped in this study. The age of the dunes is unknown; however, if they are coeval with the youngest Mississippi Valley loess deposits, they are probably on the order of 18,000 to 25,000 years old. Association of the dunes with older loess deposits is distinctly possible, however.

LITHOLOGY

20. Although the Quaternary alluvial deposits of the Western Lowlands are generally thinner than in any other major area of the Lower Mississippi Valley (average thickness about 150 ft), they are also by far the sandiest alluvial deposits. A fine-grained topstratum of basically cohesive soils is present over essentially the entire area; however, it averages only 25 ft in thickness and rarely exceeds 40 ft in thickness. Thick deposits of clays and silts in abandoned channels to depths of 120 ft and more and in extensive backswamp areas to depths of 80 to 100 ft such as occur throughout at least half of the Mississippi alluvial valley are absent in the Western Lowlands. Similarly, weak soils with high water contents and occasionally high organic contents which characterize much of the alluvial valley are scarce in the Western Lowlands, being restricted almost exclusively to small areas in the floodplains of the Black and White Rivers. The Western Lowlands contains, in the dune field areas, the only extensive surficial deposits of fine sands in the alluvial valley exclusive of the active channel of the present Mississippi River.

21. More than 80 percent of the entire alluvial sequence in the lowlands area is included in the 75- to 175-ft-thick substratum unit which is composed almost entirely of coarse-grained sediments; i.e., sands and gravels. The highest concentration of gravel is in the lower half of the substratum unit, and it is not unusual for the upper half to be composed of nothing coarser than fine- to medium-grained sand. As would be expected, the higher percentages of gravel-size materials and also the larger individual particle sizes (3 to 5 in. and more) occur in the northern part of the Western Lowlands.

22. The fine-grained topstratum deposits of the braided-stream terraces are quite uniform in thickness, averaging about 20 ft on the Qtb_3 and Qtb_4 levels and about 30 to 35 ft on the Qtb_1 and Qtb_2 levels. The greater average topstratum thickness on the higher levels is seemingly inconsistent with the higher degree of dissection imposed on a similar original thickness; however, a capping of loess or loess-like loam (as identified by the U. S. Soil Conservation Service) of 6 to 10 ft on the higher levels is the apparent reason for the difference. Braided-stream terrace topstratum deposits of over 40 ft in thickness occur only in narrow bands underlying the major relict braided gathering channels and no doubt represent fine-grained channel fill. These narrow zones should contain the only appreciable amounts of relatively soft clays and silts with high water contents. Elsewhere, the braided-stream terrace topstratum deposits consist of well oxidized, relatively high-strength silty and sandy clays.

23. Considering the meander belt deposits of the present rivers in the Western Lowlands, the point bar topstratum deposits are rather thin (less than 20 ft) and consist principally of lean clays grading downward into silts and fine sands. The backswamp deposits and abandoned channel and course fillings are mainly clays and silty clays with moderate strengths and water contents. They attain maximum thicknesses of about 30 ft.

24. Although there is a paucity of data, it appears that the point bar topstratum and abandoned channel and course deposits of the abandoned Black-St. Francis River meander belt (the Cache River terrace or Qtc) are quite similar in terms of lithology to those of the present rivers, but the thicknesses are significantly different. The point bar topstratum probably averages 5 to 10 ft thicker than on the present larger rivers, and the abandoned channels and courses possibly attain thicknesses of as much as 40 and 50 ft. These dimensions have been determined more by empirical equations involving stream surface geometry parameters than by actual borings or subsurface data; consequently, considerable error may be present.

25. The Mississippi River meander belt features present in the extreme southeast corner of the study area (Henrico and Modoc quadrangles) are typical of similar features elsewhere in the Mississippi alluvial valley. The more significant features in terms of lithology are the abandoned channels which are characterized by 90- to 100-ft-thick deposits of low-strength, high-water-content clays. The point bar topstratum deposits are generally analogous in terms of lithology to those along rivers in the lowlands area; however, occasional large swales filled with very soft clays are present. The more major swales have been mapped and are shown on the plates in this report.

GEOLOGIC STRUCTURE

26. As is the case in much of the Mississippi alluvial valley, the gross configuration of the lowlands and that of various upland areas such as Crowleys Ridge strongly suggest an underlying structural control. Moreover, various aspects of lowland physiography such as anomalous drainage patterns and depression areas suggest the presence of faulting. However, with few exceptions, major faults are unknown in the Western Lowlands either from surface or subsurface evidence. The only major exception is the Big Creek Fault Zone which trends northeast-southwest along Big Creek southwest of Helena, Ark. The physiographic evidence cited for the presence of this fault is inconclusive; however, subsurface evidence in the form of displaced horizons in the suballuvial Tertiary formations appears definitive (see Modoc quadrangle). This information was derived from borings made during a special investigation of faulting in the Lower Mississippi Valley. If the physiographic evidence is valid, it indicates that appreciable movement has occurred along the fault zone during Quaternary times; however, there is no evidence of movements during the last few thousand years.

27. During the past 100 years, the northern part of the Western Lowlands area has experienced at least three moderate earthquakes (Modified Mercalli Intensities of VI) whose epicenters were situated in the lowlands area within a 25-mile radius of Poplar Bluff, Mo. In addition, the lowlands area is sufficiently close to the seismically active New Madrid area to be affected by the more severe shocks in that region. Insofar as is known, none of the earthquakes that have occurred in the Western Lowlands have been associated with known faults and none have caused faults visible at the surface. The general stratigraphic relationships of the Quaternary deposits in the lowlands area suggest that the area is being downwarped on the west and/or uplifted on the east, with some appreciable vertical movement taking place along the Ozark Escarpment and possibly also along Crowleys Ridge. However, deep subsurface stratigraphic data do not indicate faults in these areas.

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ERA	SYSTEM	SERIES	GROUP	FORMATION OR SUBDIVISION	RANGE IN THICKNESS (FEET)	GENERALIZED SECTION	LITHOLOGY
CENOZOIC	QUATERNARY	HOLOCENE		ALLUVIUM AND CACHE R. TERRACE	0-150		Topstratum composed of gray and brown clays and silts overlying sand and gravel substratum. Topstratum deposits laid down by meandering streams in five distinct environments of deposition.
		PLEISTOCENE		BRAIDED STREAM TERRACES	0-150		Each terrace composed of a thin topstratum of silty and sandy clays overlying a sand and gravel substratum. Topstratum locally absent or veneered with dunes. Highest terrace veneered with loess or eolian silt deposits.
				(CROWLEYS RIDGE)	0-100		Light tan or gray calcareous loess (massive silty clay or clay silt) unconformably overlying fluvial, well-oxidized sands and gravels. Loess is thin and discontinuous over northern part of ridge.
	TERTIARY	EOCENE	JACKSON	YAZOO CLAY	0-420		Mostly homogeneous, fat clays with widely scattered thin zones of silty clay. Small quantities of lignitic material and occasional bentonitic layers may be present.
				MOODYS BRANCH			Fossiliferous, glauconitic, sandy clay to clayey marl with occasional indurated layers and thin silt lamina.
			CLAIBORNE	COCKFIELD			Gray to gray-brown, lignitic, silts, and fine sands. Lignite and occasionally stiff gray-brown clays occur as distinct beds. All materials highly lenticular. Silts and sands become more abundant near base of formation.
				COOK MOUNTAIN			Calcareous, glauconitic, clay, sandy clay, and sand.
				SPARTA SAND	0-1600		Massive beds of white to gray fine- to medium-grained sand, interbedded with thin lenticular beds of lignitic clay and sandy clay, and a few beds of gray to brown sandy clay and lignite.
				CANE RIVER			Green and brown clay, sandy clay, marl, and sand. Sand is most abundant in the lower part of the formation. All portions of the formation are calcareous, glauconitic, and fossiliferous.
				CARRIZO SAND			Fine to coarse, light gray to brownish-gray, micaceous sand.
			WILCOX	UNDIFF.	100-920		Fine- to medium-grained sand and sandy clay, in part lignitic, and carbonaceous clay and lignite containing a few beds of calcareous sand or clay. Massive sand beds, common only in the basal and upper portions of the unit. Some coarse and locally graveliferous sands may be present.
		PALEOCENE	MIDWAY	PORTERS CREEK	200-730		Massive blue-gray to dark-gray fissile shale, clay shale, or clay with local sandy shale and sandy clay beds. Contact with overlying Wilcox often gradational.
				CLAYTON			Gray calcareous, glauconitic, fossiliferous shale with scattered lenses of white limestone near base.
MESOZOIC	CRETACEOUS	GULFIAN		ARKADELPHIA MARL			Dark-blue fossiliferous marl interbedded with sandy limestone. May be glauconitic and chalky in part.
				NACATOCH SAND	>200		Massive crossbedded yellowish to gray fine sand. In part glauconitic and interbedded with hard sandy limestone and marl.
PALEOZOIC	PENNSYLVANIAN	ATOKA		ATOKA	5,000(?)		Dark brown to black, thinly bedded, hard shale with interbeds of dark gray to dark brown, fine-grained sandstone.

Fig. 2. Stratigraphic column, Western Lowlands

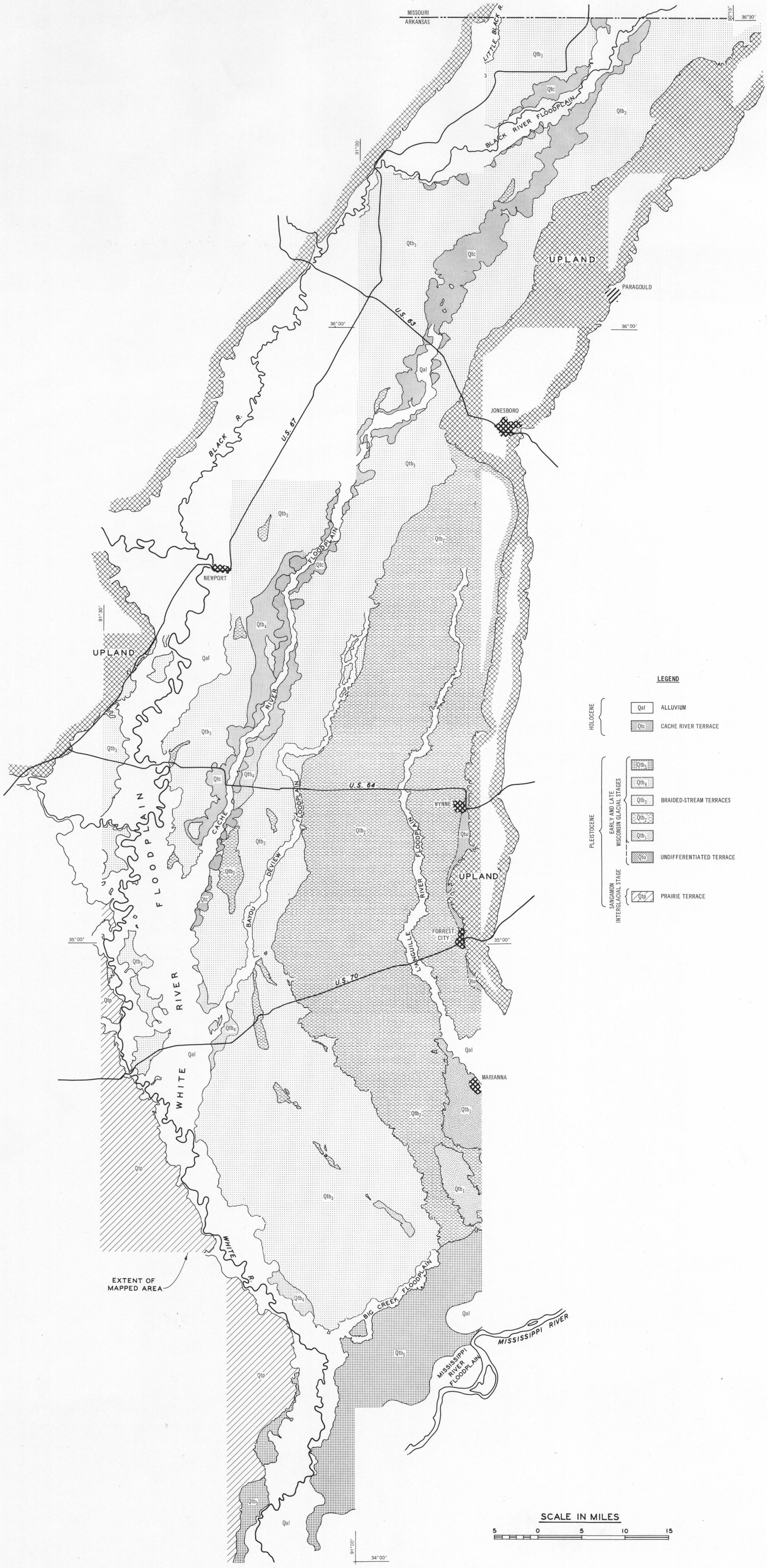

Fig. 3. Geologic map of the Western Lowlands area

FOREWORD

This study was authorized by a letter, dated 17 July 1968, from the Division Engineer, U. S. Army Engineer Division, Lower Mississippi Valley (LMVD), to the Director, U. S. Army Engineer Waterways Experiment Station (WES), subject "Status of Soils Division Projects for MRC and LMVD for FY 1968 and Request for Funds for Projects for FY 1969."

The data collection and evaluation, field reconnaissance, and aerial photo and subsurface data interpretations for the study were performed by Mr. F. L. Smith of the Geology Branch, Soils Division, WES. Dr. R. T. Saucier of the Geology Branch provided technical guidance, wrote the text of the report, and established the stratigraphic and chronologic framework for the area. Direct supervision of this study was provided by Dr. C. R. Kolb and Mr. W. B. Steinriede, Jr., of the Geology Branch; general supervision was provided by Mr. J. P. Sale, Chief of the Soils Division.

Directors of the WES during the conduct of this investigation and the preparation of this report were COL Levi A. Brown, CE, and COL Ernest D. Peixotto, CE. Technical Director was Mr. F. R. Brown.

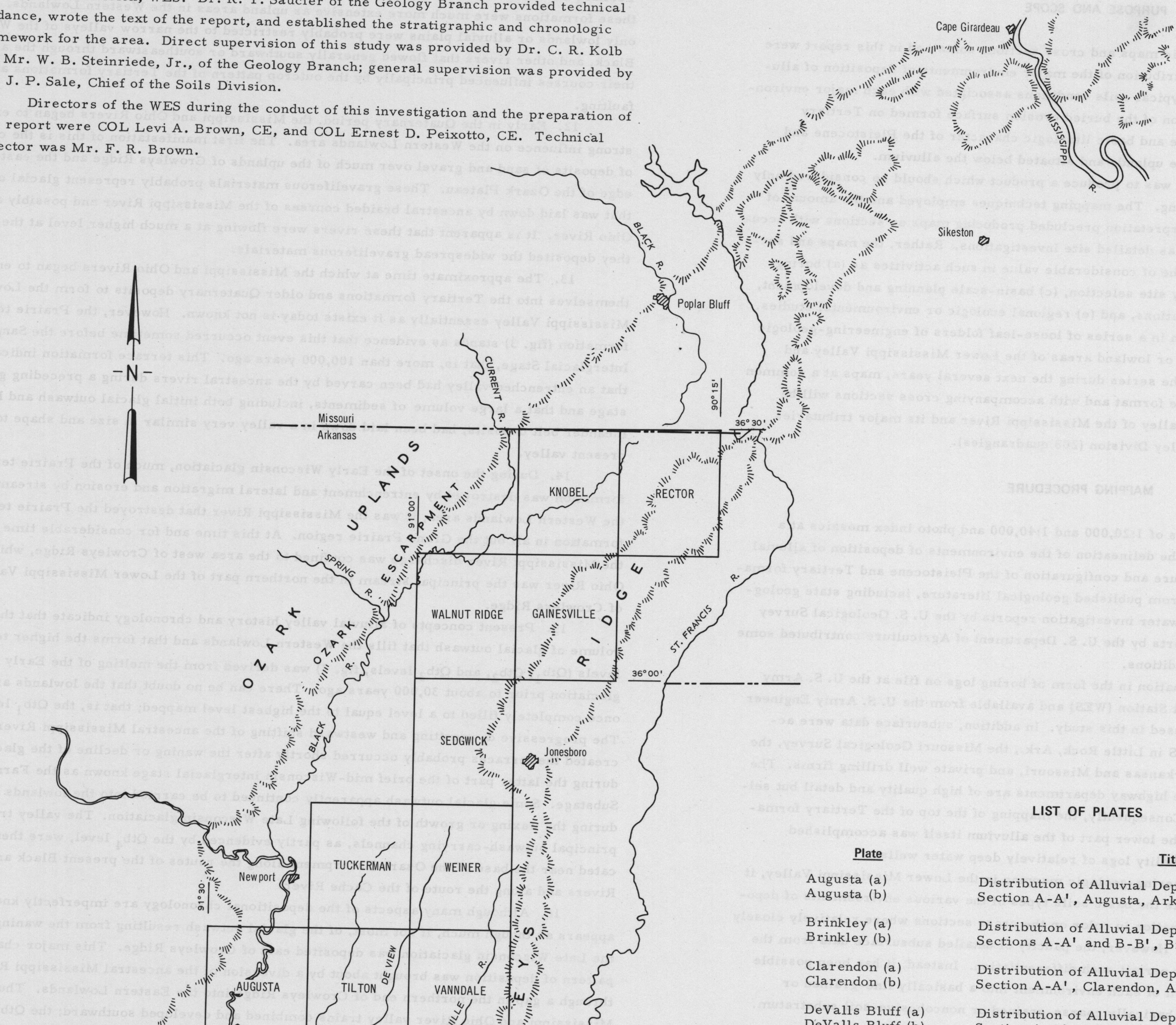

Fig. 1. Quadrangle coverage of the Western Lowlands area, Lower Mississippi Valley

LIST OF PLATES

Plate	Title
Augusta (a)	Distribution of Alluvial Deposits, Augusta, Ark.
Augusta (b)	Section A-A', Augusta, Ark.
Brinkley (a)	Distribution of Alluvial Deposits, Brinkley, Ark.
Brinkley (b)	Sections A-A' and B-B', Brinkley, Ark.
Clarendon (a)	Distribution of Alluvial Deposits, Clarendon, Ark.
Clarendon (b)	Section A-A', Clarendon, Ark.
DeValls Bluff (a)	Distribution of Alluvial Deposits, DeValls Bluff, Ark.
DeValls Bluff (b)	Section A-A', DeValls Bluff, Ark.
Gainesville (a)	Distribution of Alluvial Deposits, Gainesville, Ark.
Gainesville (b)	Section A-A', Gainesville, Ark.
Gregory (a)	Distribution of Alluvial Deposits, Gregory, Ark.
Gregory (b)	Section A-A', Gregory, Ark.
Henrico (a)	Distribution of Alluvial Deposits, Henrico, Ark.
Henrico (b)	Section A-A', Henrico, Ark.
Holly Grove (a)	Distribution of Alluvial Deposits, Holly Grove, Ark.
Holly Grove (b)	Section A-A', Holly Grove, Ark.
Hunter (a)	Distribution of Alluvial Deposits, Hunter, Ark.
Hunter (b)	Section A-A', Hunter, Ark.
Indian Bay (a)	Distribution of Alluvial Deposits, Indian Bay, Ark.
Indian Bay (b)	Section A-A', Indian Bay, Ark.
Knobel (a)	Distribution of Alluvial Deposits, Knobel, Ark.-Mo.
Knobel (b)	Section A-A', Knobel, Ark.-Mo.
Marianna (a)	Distribution of Alluvial Deposits, Marianna, Ark.
Marianna (b)	Section A-A', Marianna, Ark.
Marvell (a)	Distribution of Alluvial Deposits, Marvell, Ark.
Marvell (b)	Section A-A', Marvell, Ark.
Modoc (a)	Distribution of Alluvial Deposits, Modoc, Ark.
Modoc (b)	Section A-A', Modoc, Ark.
Rector (a)	Distribution of Alluvial Deposits, Rector, Ark.-Mo.
Rector (b)	Section A-A', Rector, Ark.-Mo.
Sedgwick (a)	Distribution of Alluvial Deposits, Sedgwick, Ark.
Sedgwick (b)	Sections A-A' and B-B', Sedgwick, Ark.
Tilton (a)	Distribution of Alluvial Deposits, Tilton, Ark.
Tilton (b)	Section A-A', Tilton, Ark.
Tuckerman (a)	Distribution of Alluvial Deposits, Tuckerman, Ark.
Tuckerman (b)	Sections A-A' and B-B', Tuckerman, Ark.
Vanndale (a)	Distribution of Alluvial Deposits, Vanndale, Ark.
Vanndale (b)	Section A-A', Vanndale, Ark.
Walnut Ridge (a)	Distribution of Alluvial Deposits, Walnut Ridge, Ark.
Walnut Ridge (b)	Sections A-A' and B-B', Walnut Ridge, Ark.
Weiner (a)	Distribution of Alluvial Deposits, Weiner, Ark.
Weiner (b)	Sections A-A' and B-B', Weiner, Ark.
Wynne (a)	Distribution of Alluvial Deposits, Wynne, Ark.
Wynne (b)	Section A-A', Wynne, Ark.